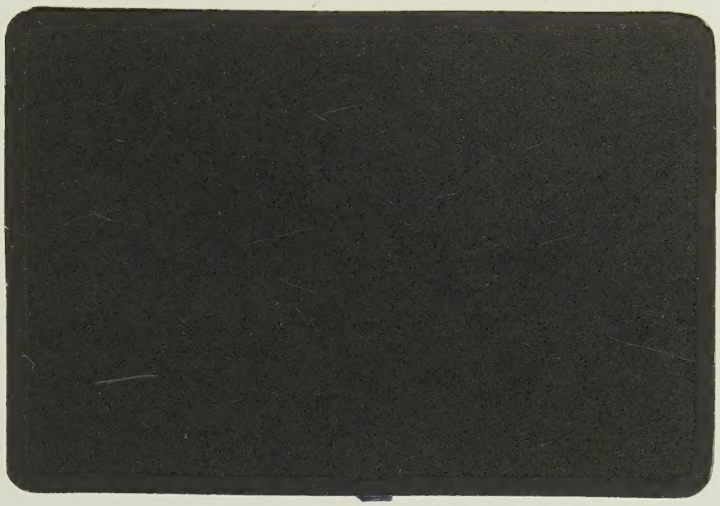

DEPARTMENT OF MARINE BOTANY

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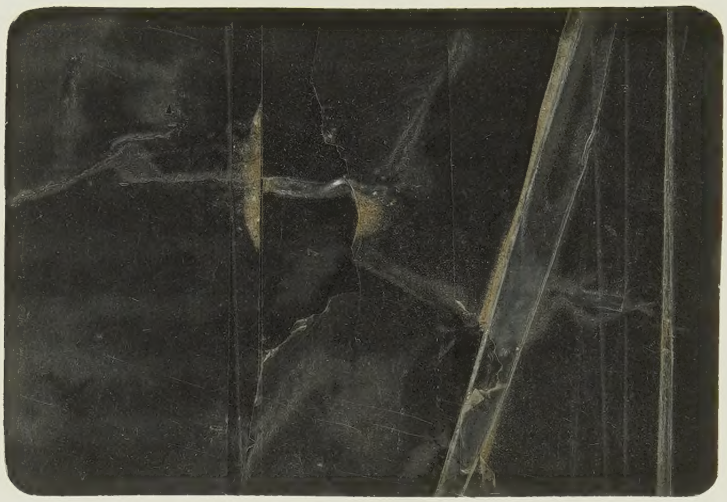

SEAWEED RESOURCES OF THE OCEAN AND THEIR GEOGRAPHICAL DISTRIBUTION

Göran Michanek
Fil. lic.

1978

AKADEMISK AVHANDLING

för filosofie doktorsexamen i marin botanik (examinator: bitr. professor Tore Levring), som enligt biologisk-geografiska sektionsnämndens beslut kommer att offentligt försvaras onsdagen den 31 maj 1978 kl. 10.15 i föreläsningssalen, Botaniska institutionen, Carl Skottsbergs Gata 22, Göteborg.

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SEAWEED RESOURCES OF THE OCEAN AND THEIR GEOGRAPHICAL DISTRIBUTION

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This dissertation is based on the following papers:

I. Michanek, G. 1975. Seaweed resources of the ocean. FAO Fish. Techn. Pap. (138): 127 p.

II. Michanek, G. 1978 a. Trends in applied phycology. Bot. Mar.: 7 p. (in print)

III. Michanek, G. 1978 b. Phytogeographic provinces and seaweed distributions. Bot. Mar. (in press)

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Seaweed resources of the ocean

A review of the seaweed resources of the world has never before been made. The main objective for this investigation has been to assess the quantities actually harvested. The potential resources of the world are of equally great interest and, although reliable information is scarce, an attempt has been made to arrive at an estimation.

The review is part of a FAO programme of evaluating world food resources, those actually in use, as well as potential ones. For a proper planning of development assistance programs, data from demographic studies have to be related regionally to data from the perspective study of world agricultural development.

In this context I was entrusted with the assessment of the world's seaweed resources. The data collection was performed, and most of the text was written, during a fix-term appointment at FAO in the Fisheries Resources Division during 1970-72. The manuscript was finalized in 1973 although postal disturbances and reshuffling of responsibilities delayed the printing. In 1975 I had an opportunity to add some recent publications during the final editing, which was, however, carried through with the main objective to bring my manuscript down to the budgeted size.

As in corresponding studies on fish and shellfish, on cephalopodes, and on turtles the area breakdown is that used by FAO in publishing fishery statistics. At the end of the book a map is included for easy reference to delineations and area numbers.

My main procedure has been to collect information from official statistics, phycological literature and through personal contacts. The earlier FAO working group on seaweed resources distributed a questionnaire at the seaweed symposium in 1968, but had only 0.5% response.

I found a more succesful way: to draft, in the shape I was aiming at, a chapter on a region so far as my information reached, and to point with emphasis at missing information. Copies of these regional sketches were distributed to specialists in the area concerned. I had 100% response. People may be hesitating to compose things from the beginning, but they are irresistably tempted to correct and amend another person's attempt within a field they know better.

Provocative wordings remain in the final version, and it is on purpose that I repeat monotonously the expression "No information available". As my review is a pioneer work, it can only aim at filling, wherever possible the blank spaces on the world map of seaweed production. The assessment of gaps in our information is also part of the survey, it is meant as a direction to phycologists in the field - and as a challenge.

The world harvest of seaweed (excl. China and green algae) can be given a preliminary breakdown on climatic zones as follows:

Harvested quantities in thousands of tons wet weight.

	Arctic and subarctic	Cold temperate	Warm temperate	Tropical
Brown algae	-	465	250	10
Red algae	-	200	400	65
	-	47.8%	46.8%	5.4%

The low share on tropical waters is striking, only 5.4% of the world harvest. Brown algae are in particular exploited in cold temperate waters, red algae in warm temperate. The ecological conditions behind these figures are worth a separate study.

Trends in applied phycology

During the last five years the commercial production of seaweed has followed new paths and still greater changes are planned for a future mariculture.

As part of a continous amending and updating of my review of world seaweed resources I am making a list of recent literature. This is scattered in a host of publications, normally not available in marine biological institutes. My list was first set up as a working tool for lectures and for answering to requests on information, which latter was during my FAO service part of my obligations, and which I still continue on a smaller scale. The literature review was not planned for publication, but through the pressure of an increasing demand for this essential information, difficult of access, I consented to the suggestion to work it out. Instead of annotating separately papers of a particular interest, I have tried to sort out and briefly describe the main trends. The bibliography brings that of "Seaweed resources of the ocean" up to date.

The aim thus is primarily informative, but more than to fill a gap in bibliographic literature. It is also an attempt to select and summarize trends, which steer the development within applied phycology. In society-related sciences, as in part in letters, it is an accepted objective to search for trends in the present. Such research is important, as, in best case, it can influence upon new projects.

The all-pervading trend, found in the papers accounted for, is the transition from collecting stage to mariculture. The production is planned exclusively for industrial products. However, it can also be observed, that in the flow of papers on seaweed utilization an urgently needed development is missing, the development of seaweed products for human demands

of proteins, trace elements, vitamins, vermifuges, and remedies for other diseases. As long as this need is completely neglected, the present use of world seaweed resources is a misuse.

Phytogeographic provinces and seaweed distributions

When, during the editing of my review on the seaweed resources of the ocean, I had to bring my manuscript down to a printable size, I chose to delete all parts on seaweed ecology. The introduction to each chapter contained such a section. I felt that these and some other parts of mainly ecological interest were least essential for the purpose of the review, and also, that I would rather develop them in a broader way and on a biological bases.

Seaweed quantities: biomass and production, are outputs of environmental conditions in shallow waters. To explain these relations, the first step would be to plot available resource data on a map of climatic regions in such waters. When I should set to work at this point, I found to my surprise that such a map does not exist.

The reason why a global mapping of the marine flora has not been tried before, and why a global marine phytogeography has not been written, may be the difficulties in adjusting and connecting earlier results. The terminology is confusing. Many authors use the term sub-tropic. Some mean the extreme parts of the tropics, others understand a warm temperate region outside the tropical zone. Where a restricted area has been investigated, too many regions are usually applied. The concepts of the terms are as varying as the concepts of the areas. So for instance the south coast of Hokkaido is s u b a r c t i c according to Okamura, subfrigid with Okazaki, south boreal according to Vinogradov, north temperate

according to Setchell, warm temperate in its western part according to Adey et al., s u b t r o p i c a l according to Bogdanov! Winter temperatures are about zero and summer temperatures about 20°C. These temperatures and the general aspect of the flora dominated by Laminariales and Fucales corresponds to northern Europe. The coastline is cold temperate.

Those who work mainly with data from the littoral belt encounter other difficulties. The vegetation is dependent on rain and sunshine, on moist or dry air. The species which endure such environmental stress will be eurytherm, euryhaline, often ubiquists. Regions are difficult to distinguish.

The main obstacle, however, has been the method usually applied in scientific approaches: species lists have been consulted, the finest brushes have been given the same value as giant kelps, presence or absence only has been asked for, and it has been expected that coastlines should be either homogenous or transitional. An example, is reproduced in Michanek 1975 p. 103: on the west coast of North America there are 14 regions. This is demonstrated in a per se excellent investigation which certainly gives a true picture of the distribution pattern along this long coastline without any sharp changes in conditions. However, the results obtained by this method in different areas will not be corresponding.

My ambition has been not to bring forth neither a new system nor a new terminology. As a starting point I have considered regional divisions already accepted in meteorology, in terrestrial plant geography, in oceanography and in marine zoology. I have tried to define corresponding regions in coastal waters - which many have done before me - and to find delineations - never tried before on a global scale. Learning from the scanty literature in the field I have tried not to get stuck in some rigorous system, but to judge from all available information,

including, of course the indispensable although not comparable results brought forth by different theoretical schools during a century of algal distribution studies.

Setchell (1893) early demonstrated clear ideas of kelp distribution in the world oceans, which he divided into 15 "districts". He wrote further papers on the geographical distribution of algae for more than forty years, but never produced a map. His "law of temperature" (1915) was interesting for its time, introducing 5°C ranges: Upper Boreal between the isotheres of 0-10°C, Lower Boreal 10-15°C, North Temperate 15-20°C, North Subtropical 20-25°C,and Tropical 25-30°C. Regrettably this system contributed to the double concepts of the term "subtropical" and had less fortunate consequences for a possible mapping of marine plant regions.

The early interest in climatic regions was soon diverted towards "climatic groups" within the floras investigated. Børgesen and Jönsson (1905) discerned five such groups in the north Atlantic: Arctic, Subarctic, Boreal-Arctic, Cold-Boreal and Warm-Boreal, and made a list of species which were found to be characteristic to these groups. Local floras were analyzed with regard to their contents of components from these groups. While four of them could as well be regarded as regions, the Boreal-Arctic is made up by cosmopolitan species within the three areas of cold waters. Various contributions to their system by other authors through additional and alternative terms is summarized by Levring (1969).

Chapman (1946) stressed the "desirable that in the future the segregation of floras into their component elements should follow an agreed scheme". He proposed such a scheme with twenty-five "geographical elements" (additions foreseen - not subtractions). These elements were the distributional patterns set up by earlier authors, not regions. For the Atlantic he adds Feldmann's Boreal Atlantic to the five classical, but of

course this summarizing group, like Boreal-Arctic, should not be squeezed in as a particular region between other zones.

My map is not only a necessary tool for the discussion of marine plant distributions and production. It is also an attempt to weed in the jungle of misconceptions, inconsistencies, and of good work with results, which do not correspond to what is done in other areas.

Acknowledgment

My first teacher in botany, Harald Kylin, drew my attention to algae, but it was under the friendly supporting guidance of Tore Levring that I came to specialize in marine botany. His interest in "research and utilization", widely known through handbooks, made impression also in his supervision; society-related research by his pupils is as appreciated as basic research.

The data-collection to the first part of my dissertation was made possible through an employment as associated expert in FAO, sponsored by SIDA. Scientists from all over the world have kindly checked my draft sections and assisted with amendments and information.

My father has followed my efforts with interest, and has contributed to our living during a necessary leave for the final preparation of the last part.

Dr. Sven Nygren, with whome I have discussed for twenty years, gave valuable criticism to the manuscript, miss Sonja Gybrant processed the text and mrs Ingrid Nüth copied pictures. Miss Marjorie Taylor edited and checked the language of the first part, the following two were consulted by Mrs Linda Schenk and Mrs Eileen Blomgren, respectively.

If my wife were not so fascinating within her own fields, it is possible that my dissertation might have been finalized earlier, but not in a richer spiritual life.

My most heartly thank to all who are mentioned, and all who are not.

References

Børgesen, F. and H. Jónsson. 1905. The distribution of the marine algae in the Arctic Sea and the northernmost part of the Atlantic. Bot. Faeröes. 3, 28 p.

Chapman, V. J. 1946. Marine algal ecology. Bot. Rev.12(10): 628-72.

Levring, T. 1969. The vegetation of the sea. In: Marine algae A survey of research and utilization. Bot. Mar. Handb. (1): 1-125.

Setchell, W. A. 1893. On the classification and geographical distribution of the Laminariaceae. Trans. Conn. Acad. 9: 333-75.

Setchell, W. A. 1915. The law of temperature connected with the distribution of marine algae. Ann. Mo. Bot. Gard., 2: 287-305.